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The Indirect Costs of Diabetic Foot Ulcers in Poland

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Abstract

Aim: The purpose of this study was to estimate the productivity loss and indirect costs associated with foot ulcers in patients with diabetic foot syndrome (DFS). An additional goal was to estimate the productivity loss and indirect costs in the population of informal caregivers of patients with DFS.

Methods: Based on a prospective survey the effects of ulcers on patients' professional activities were measured, and in addition, the disease-associated loss of productivity in the population of professionally active patients and caregivers was examined. Loss of productivity was measured using a modified WPAI questionnaire. The indirect costs of both absenteeism and presenteeism were estimated using the human capital approach.

Results: Mean absenteeism was estimated at 32.63% of the nominal working time, whereas presenteeism was estimated at 23.48% of real working time. Among informal caregivers, mean absenteeism was estimated at 13.67% of the nominal working time, and presenteeism was estimated at 27.21% of real working time. Total annual indirect costs associated with productivity loss in the patient population amounted to EUR 170.8 million, including EUR 117.3 million in costs for sickness absences and EUR 53.5 million in presenteeism costs. Total annual indirect costs associated with productivity loss in the population of informal caregivers amounted to EUR 303.3 million, including EUR 80.8 million in costs for sickness absence and EUR 222.6 million in presenteeism costs.

Conclusions: The indirect costs associated with foot ulcers in patients with DFS impose a substantial burden on the Polish economy.

Keywords: Ulceration; Diabetic foot syndrome; Diabetes, Indirect costs

Introduction

Diabetes is one of the most common chronic diseases worldwide. According to data from the World Health Organization (WHO), 347 million people in the world suffer from diabetes [1]. The International Diabetes Federation (IDF) estimates that approximately 1.9 million people in Poland have been diagnosed with diabetes, and another 650,000 people live with undiagnosed diabetes [2]. Not only is diabetes one of the main cases of mortality in the general population (responsible for approximately 5% of all deaths, including 6% to 27% of deaths among people aged 35–64 years), this condition also involves a high risk of disability [3]. It is also estimated that the risk of disability in populations with diabetes is 50–80% higher than that in the general population [4]. The main causes of disability in diabetes include vascular complications such as micro- and macroangiopathies as well as neuropathies, which lead to cardiovascular diseases, strokes, kidney diseases, blindness and lower extremity amputations [3]. Diabetic foot syndrome (DFS), i.e., ulcers, infection or deep tissue damage below the ankles in patients with diabetes, is the most common cause of lower extremity amputations in diabetes [5]. DFS is believed to be one of the most common complications of diabetes and a major determinant of disability [6]. Indeed DFS is estimated to affect one out of every four persons with diabetes [7]. Moreover, the treatment for DFS is a long-term process that can generate considerable healthcare costs, as therapy needs to be delivered by multidisciplinary teams of specialists in the fields of diabetology, general and vascular surgery, orthopedics, radiology, microbiology, neurology, physiotherapy and rehabilitation as well as specialized nursing staff [6]. Long-term treatment and frequent disability caused by foot ulcers can also generate considerable costs attributed to productivity loss. To the best of our knowledge, the indirect costs (i.e., costs associated with lost or impaired productivity at work) in the population of patients with DFS in Poland have not been previously analyzed, and only a small number of reports on this issue have been identified in the international literature. In the study by Prompers et al., the estimated indirect costs of approximately 6.4% of the total cost associated with DFS were significantly lower compared with the direct costs [8]. However, it should be noted that this study estimated only the cost of sickness absence, without taking into account the costs associated with the disability and the costs of presenteeism i.e., being at work but not fully functioning because of a medical condition. Bearing in mind the clinical complexity of DFS and the fact that this disease constitutes a significant social problem, the aim of our study was to estimate the indirect costs associated with DFS in Poland and to identify clinical factors (severity of ulcers) that could influence these costs.

Methods

The analysis covered indirect costs associated with both absenteeism and presenteeism. Loss of productivity in the population of patients and their informal caregivers was examined. A prospective survey in the population of DFS patients with active foot ulcers who were treated in ambulatory settings at the Department of Gastroenterology and Metabolic Diseases of the Medical University of Warsaw was conducted

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from September 2011 to December 2012. The survey also included these patients' informal caregivers (the survey was conducted by post). We evaluated the patients' clinical condition, i.e., the severity of ulcers using the PEDIS scale, the duration of ulceration, the diabetes type, the duration of diabetes and the duration of current treatment. Basic demographic data, including age, gender, education, place of residence and employment sector, were also collected. Loss of productivity was measured using a self-designed questionnaire and the Work Productivity and Activity Impairment (WPAI) questionnaire modified to assess the impact of foot ulcers on the productivity of patients and their caregivers [9].

Indirect costs were estimated using the human capital approach (HCA), under which the indirect costs of a disease are incurred throughout the duration of the condition/disability [10]. As a financial measure of human capital, gross value added per person employed in the national economy was used. According to data of the Central Statistical Office of Poland, this value amounted to EUR 22 919.52 in 2011 [11]. Based on the nominal number of hours worked in 2011 (1945) adjusted by the estimated number of holiday hours (9.7%), i.e., 1,756 hours worked per person employed, gross value added per person employed per 1 working hour was estimated at EUR 13.05. All amounts are provided in Euros (exchange rate: EUR 1.00 = PLN 4.20) [12].

Hypothesis testing for low-count samples (N<30) with a non-normal distribution was conducted using non-parametric tests, including the Mann Whitney-U test (to compare two groups) or the Kruskal-Wallis test (to compare more than two groups). The analysis of samples with $N \geq 30$ or a normal distribution was conducted using the Student's t-test. Evaluation of the relationship between two dichotomous variables was tested using Pearson's chi-squared test. The significance level in null hypothesis testing was set to 5% ($\alpha = 0.05$). Correlations were estimated using the Pearson correlation coefficient (r). All statistical calculations were conducted using StatSoft, Inc. (2011), STATISTICA (data analysis software system), version 10, Tulsa, Oklahoma, USA and Microsoft Office Excel 2010.

Results

Demographic and clinical characteristics of the study population

The study involved 215 patients diagnosed with DFS, with 4.4 years of DFS duration on average. Men (72%), residents of urban areas (79%) and type 2 diabetes patients (86%) prevailed, with 17.8 years representing the mean time since diagnosis. The mean population age was 62.5 years. More than 50% of patients had no perfusion abnormalities in the affected limb, and approximately 40% had a superficial full-thickness ulcer, generally without clinical symptoms of infection. In the vast majority of patients (89%), loss of protective sensation was present. The average ulcer size was 6.9 sq cm, and generally only one limb was affected. Detailed demographic and clinical characteristics of the patient population are presented in Table 1.

Only 54 (45%) respondents aged 45.8 years out of the population of 120 informal caregivers of patients with DFS were professionally active. Women (76%) and residents of urban areas (74%) prevailed. More than half of all informal caregivers were spouses, and one-fourth were children. Detailed demographics of the professionally active informal caregivers are shown in Table 1.

Effects of ulcers on professional activity

Forty-one (19.6%) patients reported being professionally active at the time of the survey, and nearly every third respondent (31.7%) declared that their foot ulcers were the direct cause for giving up their professional activities. Respectively, 40.2% and 34.3% of respondents were forced to limit or change their professional activities at some point in the past because of their foot ulcers. More than 2 out of every 5 respondents (42.4%) who changed or limited their professional activities because of their foot ulcers saw their earnings reduced by 22.9% ± 33.3% on average.

When comparing the professionally active and inactive populations, active patients were significantly younger, and the proportion of patients with higher education was significantly higher in this group. Additionally, the percentage of male patients was significantly higher in the professionally active group compared with the group of professionally inactive patients; see Table 2. No other significant differences in terms of the demographic characteristics of the compared populations were identified. The clinical profiles and severity of the changes in the limbs were comparable between the professionally active and inactive patients; see Table 2. Assessment of perfusion in the affected limb was the only exception, as impaired perfusion was significantly more common in the professionally inactive patients, and infection was more severe in the professionally active population; see Figure 1.

Loss of productivity – population of patients

Twenty-three of the 41 professionally active patients correctly completed the WPAI questionnaire and provided full clinical characteristics of their disease to analyze the impact of ulcer severity on professional activities. This population's mean nominal working time (theoretical amount of time worked and not worked) was 37.3 ± 13.6 h per week. Absenteeism was estimated to comprise 32.63% of the nominal working time, which corresponds to productivity loss of 11.17 h per week. Presenteeism was estimated at 23.48% of the real working time, which corresponds to productivity loss of 5.09 h per week. Total productivity loss was estimated at 45.41% of the nominal working time, which corresponded to productivity loss of 16.27 h per week; see Table 3. No statistically significant relationship was identified between loss of productivity (relative (%) or absolute (h) for all the measured categories, i.e., absenteeism, presenteeism and total productivity loss) and the clinical ulceration evaluated on the basis of infection severity, depth/tissue loss, sensation and perfusion. No significant correlation between productivity loss and ulcer size (sq cm) was revealed. Additionally, factors such as gender, age, place of residence, education, type of diabetes and duration of the disease had no differentiating effect on productivity loss in terms of absenteeism or presenteeism.

Productivity loss – population of informal caregivers

Forty-three of the 54 professionally active caregivers correctly completed the WPAI questionnaire and provided full clinical disease characteristics of the patients they cared for to analyze the impact of ulcer severity on the caregivers' professional activities. The mean nominal working time (theoretical amount of time worked and not worked) was 40.8 ± 15.7 h per week in this population. Absenteeism was estimated at 13.67% of the nominal working time, which corresponds to productivity loss of 3.35 h per week. Presenteeism was estimated at 27.21% of the real working time, which corresponds to productivity loss of 9.23 h per week. The total productivity loss was estimated at 35.62% of nominal working time, which corresponded to productivity loss of 12.58 h per week; see Table 3. With the exception of a significantly greater total productivity loss in the subpopulations of caregivers of

Patients		
Male, [n (%)] N = 215		155 (72%)
Age [mean (SD)] N = 213		62.5 (10.3)
Place of residence [n (%)] N = 214	Rural area	46 (21%)
	Urban area of less than 10 thousand.	8 (4%)
	Urban area of 10-20 thousand.	8 (4%)
	Urban area of 20-50 thousand.	22 (10%)
	Urban area of 50-100 thousand.	18 (8%)
	Urban area of 100-500 thousand.	14 (7%)
	Urban area of more than 500 thousand.	98 (46%)
Education [n (%)] N = 215	Primary	44 (20%)
	Secondary	129 (60%)
	Higher	42 (20%)
Type of diabetes [n (%)] N = 213	Type 1	27 (13%)
	Type 2	183 (86%)
	Other	3 (1%)
Time (years) from diagnosis of diabetes [mean (SD)] N = 211		17.8 (11.5)
Time (years) from diagnosis of DFS [mean (SD)] N = 212		4.4 (4.8)
Time (weeks) of actual ulcer treatment [mean (SD)] N = 213		53.1 (98.8)
Size of ulcers in sq cm [mean (SD)] N = 213		6.9 (18.6)
Perfusion [n (%)] N = 209	Grade 1	111 (53%)
	Grade 2	86 (41%)
	Grade 3	12 (6%)
Depth/tissue loss [n (%)] N = 212	Grade 1	85 (40%)
	Grade 2	82 (39%)
	Grade 3	45 (21%)
Infection [n (%)] N = 212	Grade 1	98 (46%)
	Grade 2	64 (30%)
	Grade 3	46 (22%)
	Grade 1	4 (2%)
Sensation [n (%)] N = 212	Grade 1	23 (11%)
	Grade 2	189 (89%)
Number of limbs affected [n (%)] N = 193	One	185 (96%)
	Both	8 (4%)
Caregivers		
Male, [n (%)] N = 54		14 (26%)
Age [mean (SD)] N = 54		45.8 (11.2)
Place of residence [n (%)] N = 53	Rural area	14 (26%)
	Urban area of less than 10 thousand.	2 (4%)
	Urban area of 10-20 thousand.	1 (2%)
	Urban area of 20-50 thousand.	9 (17%)
	Urban area of 50-100 thousand.	2 (4%)
	Urban area of 100-500 thousand.	3 (6%)
	Urban area of more than 500 thousand.	22 (42%)
Education [n (%)] N = 54	Primary	2 (4%)
	Secondary	26 (48%)
	Higher	26 (48%)
Relationship to DFS patient [n (%)] (N = 54)	Siblings	2 (4%)
	Child	15 (28%)
	Parents	2 (4%)
	Husband/wife	31 (57%)
	Other	4 (7%)

Table 1: Demographic and clinical characteristics of patients and caregivers.

patients with more pronounced depth/tissue loss, no statistically significant relationship was identified between productivity loss and clinical ulcer evaluation. Similarly, no significant linear correlation was revealed between productivity loss and ulcer size (sq cm). Factors such as gender, age, place of residence, education, relationship, type of diabetes and duration of the disease, assessed for both caregivers and patients, showed no differentiating effect on productivity loss in terms of absenteeism or presenteeism. The only differentiating factor was the employment sector, as higher productivity loss was revealed among caregivers employed in the private sector compared with caregivers employed in the public sector.

		Professionally active			Professionally inactive			p value[a]
		N	n	%	N	n	%	
Education	Primary	41	5	12.2%	168	37	22.0%	0.159
	Secondary	41	19	46.3%	168	107	63.7%	0.042
	Higher	41	17	41.5%	168	24	14.3%	< 0.001
Type of diabetes	Type 1	40	5	12.5%	167	21	12.6%	0.990
	Type 2	40	35	87.5%	167	143	85.6%	0.759
	Other	40	0	0.0%	167	3	1.8%	0.393
Place of residence	Urban area of more than 500 thousand.	41	17	41.5%	167	79	47.3%	0.501
	Urban area of 100-500 thousand	41	1	2.4%	167	13	7.8%	0.221
	Urban area of 50-100 thousand	41	5	12.2%	167	12	7.2%	0.294
	Urban area of 20-50 thousand	41	7	17.1%	167	15	9.0%	0.131
	Urban area of 10-20 thousand	41	1	2.4%	167	7	4.2%	0.601
	Urban area of less than 10 thousand	41	1	2.4%	167	6	3.6%	0.714
	Rural area	41	9	22.0%	167	35	21.0%	0.889
Male		41	36	87.8%	168	116	69.0%	0.016
Only one limb affected		36	33	91.7%	151	146	96.7%	0.181
		N	**mean (SD)**		**N**	**mean (SD)**		**p value[b]**
Age (years)		41	58.6 (7.5)		166	63.6 (10.7)		0.005
Diabetes duration (years)		39	17 (14.3)		166	18.1 (10.9)		0.588
Ulcer duration (years)		39	3.9 (4.5)		167	4.6 (4.8)		0.391
Duration of current treatment (weeks)		39	32.2 (42.3)		168	56.9 (108.5)		0.164
Size of ulcers (sq cm)		39	9.7 (32)		168	6.3 (14.2)		0.316

[a]Chi-square test
[b]Student t-test

Table 2: Comparison of professionally active vs. inactive patients with foot ulceration.

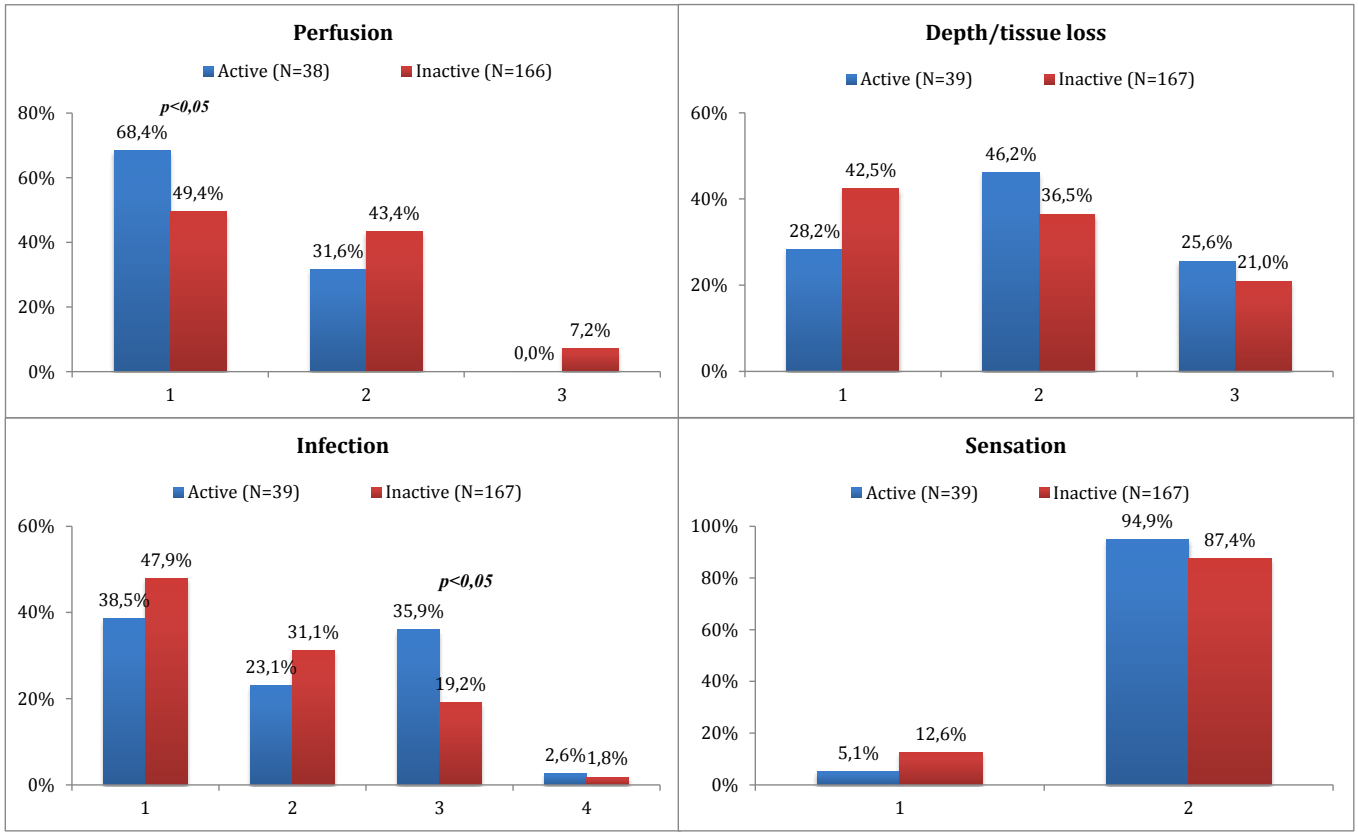

Figure 1: Comparison of ulcer severity (PEDIS scale) in the populations of professionally active vs. inactive patients.

	N	mean (SD)	median (IQR)
Patients			
Absenteeism (%)	23	32.63% (44.98%)	0.00% (0.00% - 100.00%)
Presenteeism (%)	23	23.48% (26.73)	20.00% (0.00 - 50.00%)
Total productivity loss (%)	23	45.41% (40.31%)	44.00% (10.00% - 100.00%)
Absenteeism (h)	23	11.17 (15.88)	0.00 (0.00 - 30.00)
Presenteeism (h)	23	5.09 (8.17)	0.40 (0.00 - 9.00)
Total productivity loss (h)	23	16.27 (15.02)	10.40 (2.40 - 32.00)
Informal caregivers			
Absenteeism (%)	43	13.67% (26.45%)	0.00% (0.00% - 18.75%)
Presenteeism (%)	43	27.21% (25.01%)	20.00% (10.00% - 40.00%)
Total productivity loss (%)	43	35.62% (32.39%)	30.00% (10.00% - 62.11%)
Absenteeism (h)	43	3.35 (4.80)	0.00 (0.00 - 8.00)
Presenteeism (h)	43	9.23 (8.55)	8.00 (0.00 - 14.00)
Total productivity loss (h)	43	12.58 (11.58)	10.00 (4.00 - 23.60)

Table 3: Productivity loss in the populations of patients and informal caregivers.

Indirect costs

Based on a review of epidemiological data, the prevalence of foot ulceration in DFS patients in Poland was estimated at approximately 80,000 (47,000 to 128,000). Based on the working population percentage (19.6%) calculated in the study, the population of working patients with foot ulceration in DFS in Poland was estimated at approximately 15,500 (9,200–25,000). For the calculated population and the estimated productivity loss per patient, the total annual indirect costs associated with productivity loss amounted to EUR 170.8 million (EUR 101.6 million–276.5 million), including EUR 117.3 million in costs for sickness absence (EUR 69.8 million–189.8 million) and EUR 53.5 million in presenteeism costs (EUR 31.8 million–86.5 million).

By relying on the calculated proportion of professionally active informal caregivers of DFS patients with foot ulcers (45%), the estimated population of professionally active informal caregivers was estimated at 35,500 (21,100–57,500) in Poland. For the calculated population of informal caregivers and the estimated productivity loss per caregiver, total annual indirect costs associated with productivity loss amounted to EUR 303.3 million (EUR 180.6 million–491.1 million), including EUR 80.8 million in costs for sickness absence (EUR 48.1 million–130.8 million) and EUR 222.6 million in presenteeism costs (EUR 132.5 million–360.3 million).

Total indirect costs in the populations of patients and their informal caregivers amounted to EUR 474.1 million (EUR 282.2 million–767.6 million), including EUR 198.1 million in costs for sickness absence (EUR 117.9 million–320.7 million) and EUR 276.0 million in presenteeism costs (EUR 164.3 million–446.9 million).

Discussion

To our knowledge, no comprehensive analysis of indirect costs associated with productivity loss in the population of DFS patients has been published thus far. In previous studies [8,13], indirect cost estimates were limited to the costs of sickness absence or sickness absence and disability [14]. The present study was the first to assess indirect costs in this patient population in terms of indirect costs associated with both absenteeism and presenteeism. Additionally, this is the first study to evaluate the costs of productivity loss in the population of informal caregivers of DFS patients with foot ulcers. Indeed, the estimated productivity loss in the population of patients with foot ulcers and their informal caregivers imposes a significant burden on the Polish economy—the total indirect costs of nearly EUR 475 million account for approximately 0.12% of Poland's GDP (2012) [15]. It should also be noted that these costs do not include two important categories of indirect costs, i.e., the costs of premature death and the costs of disability. In the case of premature mortality, foot ulcers can more than double the risk of death in persons with diabetes compared to the population of persons with diabetes without foot ulcers [16]. However, mortality in DFS patients appears to be more often attributed to other diseases or to complications of diabetes than to the ulcers alone. According to Moulik et al., mortality from cardiovascular diseases (38%) and pulmonary complications (35%) prevails in the population of patients with DFS [17]. Therefore, foot ulcers appear to be only rarely the direct cause of death in this patient population, which means that indirect costs associated with premature death are difficult to estimate and validate. The indirect costs of disability are also difficult to estimate because of the lack of Polish-specific data that would allow for calculating the percentage of DFS patients of working age who give up their professional activities because of foot ulcers. In this study, the estimated working activity in the population of DFS patients with ulcers amounted to 19.6% and was significantly lower compared to the general population of similar ages (32.9%) [12]. Given that 38.7% of professionally inactive respondents declared DFS to be the direct reason they had abandoned their professional activities, and based on the difference between theoretical and actual professional activity in the study population (32.9% vs. 19.6%), it can be estimated that this disability reduced the professionally active population of DFS patients by approximately 5.1% (i.e., approximately 4,000 people annually gave up their professional activities because of ulcer-related disability). Assuming that this population had the same productivity as the population studied in this analysis (i.e., real working time of approximately 21.0 h), the estimated indirect costs related to disability amount to roughly EUR 57.8 million.

Estimations of indirect costs are difficult to verify due to the lack of similar estimates for Poland or other countries. The 2006 study by Kawalec and Pilc, in which the indirect costs of diabetes in Poland were estimated to be PLN 6.3 billion (i.e., approximately EUR 1.5 billion), can be used (at least to some extent) for comparison [18]. Based on these data, it can be assumed that indirect costs associated with foot ulceration in DFS account for a significant (approximately 10%) share of the total indirect costs associated with diabetes. However, it should be noted that Kawalec and Pilc used a different methodology for measuring indirect costs; for example, the cost of reduced productivity at work was not accounted for. The indirect costs estimated in this study are also difficult to compare to the direct costs of treating DFS patients

in Poland. The only calculation of cost of care provided by Kawalec and Pilc was roughly PLN 22.5 million (EUR 5.4 million) for DFS care hospitalization and roughly PLN 860 million (EUR 205 million) for outpatient care in 2002 [19]. According to the latest NHF data, the costs of hospitalization for diabetic foot ulcers amounted to more than EUR 4.4 million in 2013; however, studies indicate that the actual costs of hospitalization are at least two times higher [20,21]. Despite the lack of accurate and up-to-date estimates of the direct costs of DFS treatment in Poland, it can be concluded from the available data that the indirect costs associated with this disease are at least comparable with, and in some cases greatly exceed, the direct costs related to hospital care.

The last issue to discuss is whether the treatment of foot ulcers makes economic sense from the point of view of population productivity. Our study revealed that the professional activity of DFS patients with foot ulcers was clearly lower in comparison to that of the general population. Moreover, it was also demonstrated that the severity of ulcers, and particularly their size, had no significant effect on productivity loss. Attention should also be paid to the fact that diabetic foot ulcers require multidisciplinary, long-term and intensive treatment and that this treatment often fails to provide any clinically satisfactory improvement [22]. Thus, the question arises of whether it would be economically more justifiable to use surgical treatment (i.e., limb amputation) instead of conservative treatment (limb preserving), especially in light of indications of the increased efficiency of this type of intervention [23]. Apart from the clinical aspect, it is worth noting that a large percentage of patients after amputation (approximately 34%) do not return to work or are forced to change their professional activities [24]. According to our study, although the proportion of professionally active patients with DFS was lower than the estimate for the general population (19.6% vs. 32.9%), professionally active patients with DFS generate a fairly substantial added value to the economy (estimated at roughly EUR 221 million). With amputation, more than one out of three patients would not return to work, and the potential indirect costs associated with amputation in this population would amount to more than EUR 75 million. Moreover, it should be noted that these costs are incremental in relation to the costs estimated in this analysis, and therefore amputation would cause at least a 50% increase in productivity loss costs.

In conclusion, the present study indicates that indirect costs associated with foot ulcers in patients with DFS impose a substantial burden on the Polish economy, which should be taken into account in the adoption of any healthcare-related financial decisions referring to this population of patients.

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